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"Effects of mesh size and effort changes on the ibero-atlantic hake (Merluccius merluccius L.) fishery (Div. VIIIc (W) + IXa)"

by

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Summary

This paper concerns Hake fishery from the North of Galicia (Spain) to the South of Portugal. It represents one more attempt in obtaining more informations about the exploitation state of hake stock in this area.

The aim of this study is to assess the immediate and long-term effects in this fishery with different fishing strategies. The models used were the following:

a) increases in mesh-size: - Gulland (1961), Jones (1974), Ricker (1975), Cadima (1976,1978).

b) increases in mesh-size and changes in fishing effort: - Jones (1974) and Ricker (1975).

To apply such methods we used the data concerning the mean catches (from 1974 to 1977) belonging to the Galician and Portuguese fleets.

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Resumé

Ce travail concerne la pêcherie du merlu de la côte nord de la Galice (Espagne), jusqu'au sud du Portugal.

Il répresente un essai en plus pour améliorernotre connaissance sur l'état d'exploitation du stock du merlu dans cette même region.

Le but de cet étude c'est l'évaluation des effects immédiats et à long terme sur la pêcherie selon des stratégies de pêche différentes.

Les modèles appliqués ont été les suivants:

a) pour les accroissements des maillages: Gulland (1961), Jones (1974), Ricker (1975), Cadima (1976,1978).

b) pour les variations de l'effort et augmentationsdes maillages: Jones (1974) et Ricker (1975).

Pour l'application des méthodes mentionnées, nous avons utilisé les données rélatives à la moyenne des captures réalisées par les flotilles espagnole (Galicienne) et portugaise, pendant la période 1974-77.

I. INTRODUCTION

After the last meeting of the Hake Working Group (March, 1978), the Spanish and Portuguese participants considered the advantage of a more accurate review of the hake fishery in div. VIIIc (West) + IXa, attending the whole available information till the end of 1977.

Considering the common exploitation area, from the Northern coast of Galicia to the South of Portugal, it was considered important to assess the long-term effects of changes in mesh-size and fishing effort, using different methods.

After some preliminary contacts between the IEO (Vigo) and INIP (Lisboa), it was possible to make the present paper, which represents one more attempt to a better knowledge of the hake stock (mainly exploited by the two countries) already considered as overexploited.

The intention of this study is to point out some results in order to propose certain recomendations to protect the stock.

II. GEARS

The table below shows the main characteristics of the Portuguese and Spanish fleets fishing on hake. We must mention that for both countries the figures refer to the average during the period 1974-77.

The Spanish fleet only concerns the Galician ones.

Fleets	Nº. of boats	$\bar{HP}$	$\bar{GRT}$	Hake ton/year	Mesh Size (mm)
Portuguese trawl	105	600	150	3 340	40
Spanish trawl	230	400	143	8 800	40
Portuguese artisanal (1)	8 000*	.	15*	5 870	(1)
Spanish longline	180	170	37	2 400	-
Spanish gillnets	114	189	38	2 850	80-110
Spanish small gillnets	428	25	25	1 000	55-65

* estimated

(1) Longline + gillnets (mesh size 70-110 mm)

. unknown

III. MATERIAL AND METHODS

1. BASE DATA

1.1. Samplings

The Portuguese hake sampling program was realized at the most important fishing harbours and concerns trawl and artisanal (gillnets + longlines) landings. Portuguese fish measurements were made to the nearest centimeter, although length distributions were converted to the lowest centimeter in order to treat all the data together (spanish and portuguese ones).

The Portuguese sampling didn't include the discards, concerning the smallest length groups.

The Spanish samples were obtained on board of a research vessel, fishing vessels and at the main fishing harbours.

The whole length composition was presented in five centimeters groups.

The table 1 shows the mean length distribution in the last four years (1974-77) of portuguese and spanish catches, and the total of both. The spanish length distribution concerns the different gears used (trawling, longlines, gillnets and small gillnets) and the portuguese ones trawling and artisanal (longlines + gillnets).

Figure 1 presents, for each length group, the catches in numbers (per mile) for each gear related to the total catches (%o).

1.2. Catches

The Spanish and Portuguese catches of hake refer to the mean values for the period 1974-77.

Concerning the Spanish trawl catches we notice, for the two last years, a decrease in the values of the smallest length groups. Due to this, there are some differences between those values and the values presented in the paper C.M. 1977/G:9, where the catches of 1977 have not been included.

The Spanish catches only concern the Galicia fleet, considering that the catches of hake from boats based at other harbours are not important in terms of total values.

1.3. Parameters

We have adopted some parameters selected in the ICES Hake Working Group (1976) (C.M. 1977/G:3):

a) Growth: the v. Bertalanffy equation

$$l_t = 134\ (1 - e^{-0.07(t+0.78)})$$

where $L_\infty = 134$ cm

$K = 0.07$ age^{-1}

$t_o = -0.78$ age

b) Length - Weight Key:

$$W\ (kg) = 0.0000051\ L^{3.074}\ (cm)$$

c) Natural mortality rate:

$$M = 0.2$$

d) Final exploitation rate (for cohort analysis)

$\frac{F}{Z} = 0.5$, according to final fishing mortality

rate $F = 0.2$, adopted in the last Hake W.G. (1978).

1.4. Selectivity

The selection factor used for trawl nets (nylon) was 3.6. The percentage of retention was made fitting the selection curve to the logistic one (table 2).

We must refer that with the new selectivity adopted in the last Hake W.G. (1978), the results would be different from the present ones. Nevertheless we prefered to use the old selectivity on this study.

2. MODELS

On the present study we made some simulations of changes in trawl mesh-size as well as of fishing effort.

With the actual mean mesh-size of 40mm we essaied increases to 50, 60, 80 and 100mm, using the following methods: Jones (1974), Ricker (1975), Gulland (1961), Cadima (1976) and Cadima modified (1978 - Appendix 1, personal communication).

The changes in fishing effort were made applying Jones's Model (1974) and Rickermulty-gears (1975). These changes were: $\pm$ 25% and $\pm$ 50% for trawl and the same variations for all gears.

2.1. Jones's and Ricker's models

For Jones's (1974) and Ricker's (1975) models, we first made an analysis of the actual fishing mortality vector, according to the cohort analysis model with length distributions (Jones 1974).

Later on, using the actual fishing mortality vector splited for each gear, we have simulated the increases in trawl mesh-size and changes in fishing effort. This was done for trawl and all gears, in order to estimate the long-term effects on fishery.

2.2. GULLAND'S, CADIMA'S and CADIMA'S MODIFIED MODELS

With Gulland's (1961) and Cadima's (1976,1978) models we assessed the

immediate and long-term effects on fishery, owing to the same increases in trawl mesh-size.

For Gulland's model the values of $t' = (\frac{t_2 - t_1}{2})$ were estimated according to the selectivity adopted (table 2):

mesh-size (mm)	t'
50	0.22
60	0.45
80	0.92
100	1.43

The exploitation rate (E) for Gulland's and Cadima's (1976) models, was estimated from the cohort analysis with length distributions, which gave a mean value of 0.8 for all increases in mesh-size.

For Cadima's (1978) method we adopted two mean values for E_A and E_B, estimated from the cohort analysis, consequentely we obtained for each mesh-size, four results in the long-term effects.

IV. RESULTS

The results are presented as percentages (%) of the mean level of landings, during 1974-77.

1. IMMEDIATE LOSSES

Table 3 shows the immediate losses that would be expected if trawl mesh-sizes were increased to 50, 60, 80 and 100mm. The results are splited for the portuguese and spanish trawl, for both and for all gears.

2. LONG-TERM EFFECTS

Table 4 presents long-term gains assuming that the trawl mesh-size increased and fishing effort remained on the level of 1974-77. These long-term effects were calculated using Jones's Ricker's, Gulland's and Cadima's models.

Table 5 shows values estimated from Cadima's modified method. For each increase of mesh-size four values of long-term gains are presented.

Table 6 presents the results obtained using Jones's and Ricker's models, assuming increases in mesh-size and different levels of fishing effort ($\pm$ 25% and $\pm$ 50% for trawl fishery and all gears).

V. CONCLUSIONS

The application of those models assumes that the hake population is in equilibrium and the mean length distribution of catches for the period 1974-77 represents a cohort. For those two reasons we recognized some limitations on the results.

The main conclusions are:

1. With the actual trawl mesh-size it is evident the overexploitation of the smallest length groups (table and figure 1).

2. For that reason we recognize the need of an immediate increase in the cod-end mesh to 60mm. This increase will produce a small immediate decrease in the total yield (table 3).

3. It would be quite convenient to the fishery decrease the fishing effort (table 6). Nevertheless it will be possible to get some long-term benefits remaining the current level of fishing effort but using a 60mm mesh-size (table 4 and 5).

4. For a best knowledge of the hake fishery it is essential that both countries improve their catch statistics (including discards) and samplings.
   It is also important to begin and improve growth and selectivity studies for this fishing area.

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Table 1. HAKE. Total numbers landed (in thousands) by gears
Div. VIII c (W) + IX a (1974-77)

Length Group (cm)	Mean Weight (kg)	PORTUGAL		SPAIN				TOTAL
		Artisanal (1)	Trawl	Trawl	Longline	Gillnet	Small gillnet	
5- 9	0.002			2 497				2 497
10-14	0.012		10	45 626				45 636
15-19	0.034	11	711	62 474				63 196
20-24	0.073	18	4 769	21 547			231	26 565
25-29	0.136	104	4 900	7 896			1 140	14 040
30-34	0.227	114	3 117	2 904			1 865	8 000
35-39	0.352	201	1 915	1 079	3		680	3 878
40-44	0.517	553	626	1 014	32	10	198	2 433
45-49	0.727	776	279	614	79	33	101	1 882
50-54	0.989	787	97	371	174	100		1 529
55-59	1.309	810	85	220	411	232		1 758
60-64	1.691	610	55	188	425	368		1 646
65-69	2.142	369	27	126	228	370		1 120
70-74	2.668	212	8	37	102	221		580
75-79	3.276	106	1	21	31	78		237
> 80	5.000	66		26	10	23		125
TOTAL		4 737	16 600	146 640	1 495	1 435	4 215	175 122
Corresponding Weight (tons) (1974-1977)		5 870	3 340	8 800	2 400	2 850	1 000	24 260
Mean Mesh Size (mm)		-	40	40	-	-	-	-

(1) Includes longline + gillnet.

Table 2 - Selectivity data adopted

Length Group \ Mesh Size (mm)	40	50	60	80	100
5 - 9	0.023	0.003	0.0005	0.000	0.000
10 -14	0.264	0.049	0.007	0.000	0.000
15 -19	0.842	0.433	0.098	0.002	0.000
20 -24	0.988	0.919	0.619	0.032	0.001
25 -29	0.999	0.994	0.960	0.331	0.010
30 -34	1.000	1.000	0.997	0.881	0.131
35 -39			1.000	0.991	0.692
40 -44				0.999	0.971
45 -49				1.000	0.998
50 -54					1.000
l_c	14.4	18.00	21.60	28.80	36.00
t_c	0.84	1.28	1.73	2.68	3.69

S.F. = 3.6

Adjusted to logistic curve $R = 1 - \frac{1}{1 + e^{-a(l_c - 1)}}$

$a = 0.54$

Table 3 - HAKE. Immediate losses in % (by weight) for increases in mesh size (Div. VIII c (W) + IX a)

Gear \ Mesh Size (mm)	50	60	80	100
Portuguese Trawl	1	5	27	56
Spanish Trawl	18	34	56	68
Portuguese and Spanish Trawl	13	26	48	65
All Gears	7	13	24	32

Table 4 - HAKE. Long-term gains in % (by weight) for increases in mesh size (Div. VIII c (W) + IX a)

Model \ Mesh Size (mm)	50	60	80	100
Ricker	38	75	121	161
Jones	42	83	146	184
Gulland	43	102	230	368
Cadima	42	99	220	360

Table 5 - HAKE. Long-term gains in % (by weight) for increases in mesh size, using Cadima's modified method

	Mesh Size							
	50 mm		60 mm		80 mm		100 mm	
E_B \ E_A	0.6	0.7	0.6	0.7	0.6	0.7	0.6	0.7
0.7	33	35	72	79	140	166	229	275
0.8	38	41	82	91	157	187	252	306

Table 6 - HAKE. Long-term gains in % (by weight) for increases in trawl mesh size and changes in fishing effort (Div. VIIIc (W) + IXa)

Mesh-size (mm) / Effort change %	50		60		80		100	
TRAWL	Ricker	Jones	Ricker	Jones	Ricker	Jones	Ricker	Jones
- 25%	62	63	93	103	140	160	164	189
+ 25%	11	20	59	63	121	134	157	178
- 50%	90	114	116	134	150	174	167	195
+ 50%	7	3	45	47	112	123	154	173
ALL GEARS								
- 25%	57	69	89	106	132	159	155	188
+ 25%	20	19	59	60	121	137	158	174
- 50%	68	92	90	119	118	152	131	174
+ 50%	4	1	44	43	110	116	149	159

FIG 1—LENGTHS COMPOSITION OF HAKE (MERLUCCIUS MERLUCCIUS L.)
DIV VIII-c(W)+IX-a (1974-1977)